Center Innovation Fund: KSC CIF

Mars Propellant Production with Ionic Liquids

Completed Technology Project (2014 - 2015)

Project Introduction

This project seeks to develop a single vessel for carbon dioxide (CO_2) capture and electrolysis for in situ Mars propellant production by eliminating several steps of CO_2 processing, two cryocoolers, a high temperature reactor, a recycle pump, and a water condenser; thus greatly reducing mass, volume, and power.

Electrolysis of CO_2 captured by Ionic Liquids (ILs) and H_2O directly to CH_4 and O_2 has the potential to be much more efficient than CO_2 freezing/methanation/water electrolysis by having five less process steps, ~50% less mass, and ~25% lower energy requirements. The objectives are to verify these advantages that would greatly improve in situ Mars propellant production for Mars Sample Return and human missions by reducing power, mass, and complexity through the use of a single vessel for CO_2 capture and electrolysis to propellant. These steps have not been demonstrated together for Mars applications, which are quite demanding.

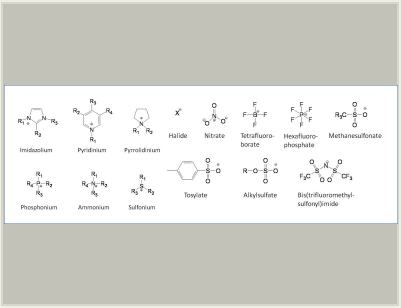
Electrolysis of CO_2 + H_2O in ionic liquids to CH_4 and O_2 has not been demonstrated, TRL = 2. The expected TRL at completion of the research effort is TRL = 4.

Anticipated Benefits

Propellant production and oxygen production for life support for human Mars missions in the 2030s at reduced mass and power. Demonstration on a Mars Sample Return mission in the 2020s would verify the technology for human missions.

SpaceX has declared its intentions to send settlers to Mars. Propellant and oxygen production would be essential for such efforts.

The Department of Energy could benefit from a successful outcome of this project.



Typical Ionic Liquid Cations and Anions

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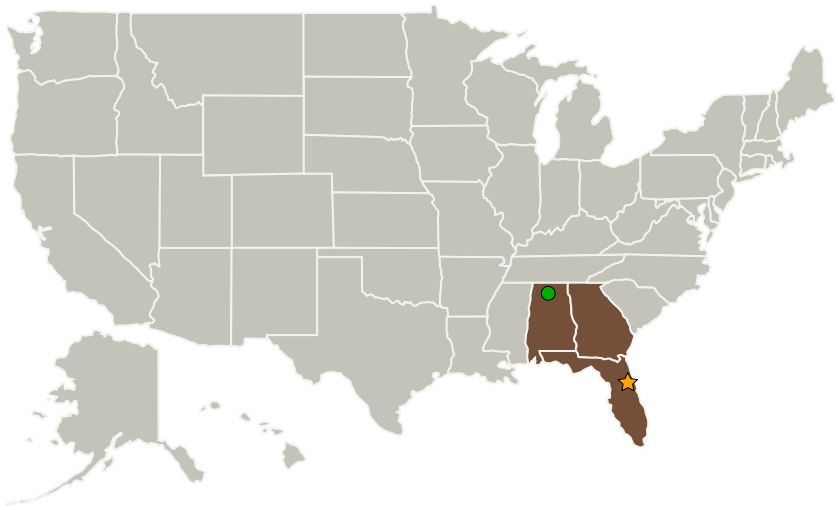
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
AZ Technology, Inc.	Supporting Organization	Industry Veteran-Owned Small Business (VOSB), Women-Owned Small Business (WOSB)	Huntsville, Alabama
●Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Co-Funding Partners	Type	Location
Mercer University	Academia	Macon, Georgia

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Kennedy Space Center (KSC)

Responsible Program:

Center Innovation Fund: KSC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

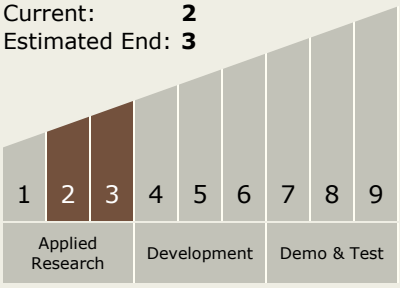
Barbara L Brown

Principal Investigator:

Anthony C Muscatello

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**

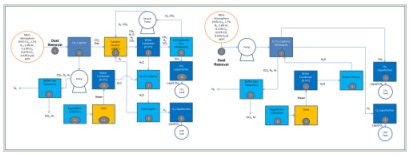


Mars Propellant Production with Ionic Liquids

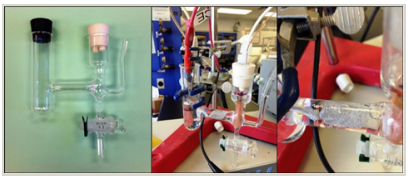
Completed Technology Project (2014 - 2015)

Primary U.S. Work Locations	
Alabama	Florida
Georgia	

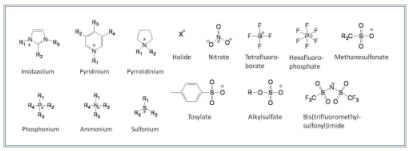
Images



Comparison of Process Steps
Comparison of Process Steps for Freezing CO2/Sabatier/Electrolysis and CO2 Capture/Ionic Liquid Electrolysis
(https://techport.nasa.gov/image/16058)



Electrolysis of CO2
Electrolysis of CO2 in an Ionic Liquid (Right Electrode) and Water (Left Electrode)
(https://techport.nasa.gov/image/16054)



Typical Ionic Liquid Cations and Anions
Typical Ionic Liquid Cations and Anions
(https://techport.nasa.gov/image/16073)

Links

KSC-13986
(no url provided)

Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - TX07.1 In-Situ Resource Utilization
    - TX07.1.3 Resource Processing for Production of Mission Consumables